PoE Switches for Industrial Networking

Alvis Chen, Business Development Manager

Alvis.Chen@moxa.com

Introduction

PoE (Power over Ethernet) is one of the hottest topics in Ethernet networking applications today. According to recent IDC forecasts, total market sales for PoE devices will reach US$1.14 billion by 2009 with a 65% annual growth rate. In addition to commercial IT applications, more and more PoE technologies are being deployed in outdoor surveillance systems for industrial operations, such as PoE networking for rolling stock in railways. In this white paper, we will introduce the basics of PoE technology and the new 802.3at standard, followed by a discussion on the required functions and benefits of adopting PoE switches for industrial networking.

PoE Basics

PoE technology allows data and electric power to be simultaneously supplied to remote devices over an Ethernet network. The need to transmit power over Ethernet cables was first recognized by several companies, including 3Com, Intel, Mitel, National Semiconductor, Nortel, and PowerDsine, but each had its own method of implementing the technology. In 1999, the IEEE started to standardize the number of proprietary implementations that were available at the time. The IEEE 802.3af standard approved in 2003 established common specifications for implementing PoE networks. A typical PoE system requires both power sourcing equipment

Released on February 5, 2009

How to contact Moxa
Tel: 1-714-528-6777
Fax: 1-714-528-6778
Web: www.moxa.com
Email: info@moxa.com

MOXA®

This document was produced by the Moxa Technical Writing Center (TWC). Please send your comments or suggestions about this or other Moxa documents to twc@moxa.com.

and powered devices.

Power Sourcing Equipment (PSE)

PoE networking requires power sourcing equipment (PSE), such as a switch or hub, to provide power to various devices. The IEEE 802.3af standard designates 15.40 watts as the maximum continuous power output allowed per power sourcing device.

Powered Devices (PD)

Devices that are powered by the sourcing equipment in a PoE network may include IP cameras, IP phones, and wireless access points. The maximum power usage of powered devices (PD) is 12.95 watts according to the IEEE 802.3af standard. Power over Ethernet can be installed using either a PoE midspan system or PoE switches. The figure below shows a PoE midspan system where an existing Ethernet switch is connected to an intermediary power source to inject power into the Ethernet cables that connect to various powered devices. In this setup, a PoE midspan hub serves as the power sourcing equipment.
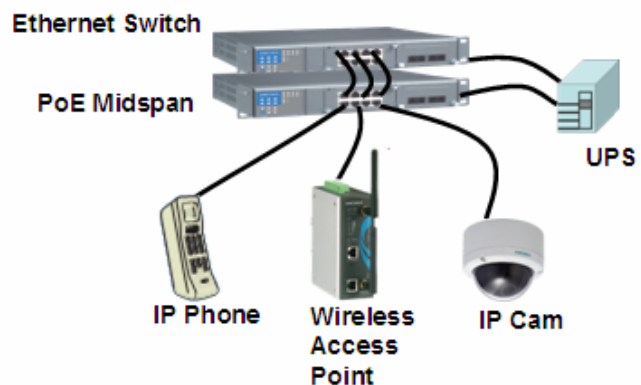
The benefit of using a midspan solution is the ability to quickly upgrade an existing Ethernet network for PoE applications. On the other hand, newer PoE switches offer a more integrated solution by incorporating the midspan hub's PSE function.

How PoE Works

Power over Ethernet uses standard Category 5 (CAT-5) Ethernet cables as specified by the IEEE 802.3af standard. Although CAT-5 cables are composed of four twisted pairs, only two of these pairs are used for 10BaseT and 100BaseT data transmission. There are two ways to use CAT-5 cables to simultaneously transmit data and power:

- **Power through the "spare pair"**
  In Figure 2, the twisted pair on pins 4 and 5 is connected to form the positive electric power supply, while the pair on pins 7 and 8 is connected to form the negative supply. Each pair can accommodate either polarity.
- **Power through the "signal pair"**
  DC power can be applied to the center tap of the isolation transformer without upsetting the data transfer since CAT-5 pairs are transformer coupled at each end. As shown in Figure 3, the twisted pair on pins 3 and 6 and the pair on pins 1 and 2 can be of either polarity.

The IEEE 802.af standard specifies that all power sourcing equipment (PSE) and powered devices (PD) must be compatible with both methods above. However, only one of the methods may be used at a time.

Power Through the "Signal Pair"

Power Through the "Spare Pair"
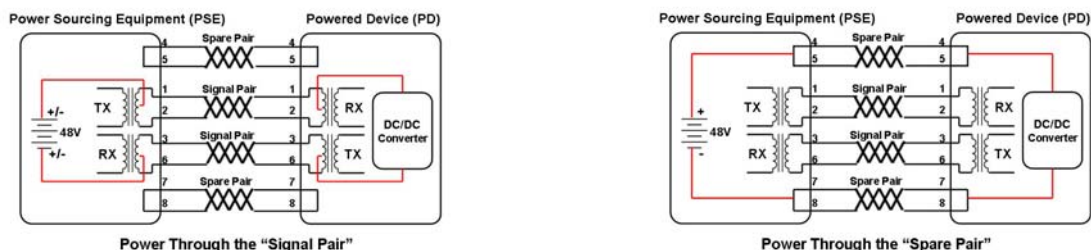
PD Classification

Since powered devices may require different power ranges, IEEE 802.3af has classified PDs according to their power consumption. By providing the power sourcing equipment with its power range, the PD allows the PSE to supply power with greater efficiency. The following table shows the different PD classes and the PSE power output for each corresponding PD power range.

Class Signature	Usage	Min. Power Levels output at Power Source Equipment	Power Available for the Power Device
0	Default	15.4W	0.44W–12.95W
1	Optional	4.0W	0.44W–3.84W
2	Optional	7.0W	3.84W–6.49W
3	Optional	15.4W	6.49W–12.95W
4	Reserved	Same As Class 0	Reserved

Powered Device Classification

The New 802.3at Standard

In September 2005, the IEEE 802.3at task force began work on a new standard known as PoE+, which would allow standard Ethernet CAT-5 cables to supply up to 24 watts of power by using both twisted pairs. With more power available, Power over Ethernet applications will be able to accommodate self-powered devices including thin clients, PTZ cameras, WiMAX transmitters, and videophones. The objectives for the new 802.3at standard include the following:

- Operability on Category 5 and higher infrastructure
- Adherence to relevant 802.3af power safety rules and limitations
- 802.3at PSE must be backwards compatible with 802.3af PSE
- Maximum power within practical limits provided to PDs (at least 24 watts)

- Indication that an 802.3at PSE is required when connecting an 802.3at PD to a legacy 802.3af PSE

The following table shows PDs that will require more power:

Market	Application	Request Power Range
Security	PZT network camera	~20W
WLAN	Outdoor access point 802.1n access point	20~30W ~20W
IP Telephone	Video IP Phone	15~25W
Other New Markets	RFID Reader/Access control Industrial Sensors Laptop POS, Kiosks	~25W 1~30W >70W 13~60W

Future PoE Devices and Power Ranges

Some manufactures also provide nonstandard power sourcing equipment and proprietary powered devices. It should be noted that interoperability between different brands may not be possible since these solutions are nonstandard products. In addition, PoE+ is likely to support two-pair power up to 30 watts and four-pair power for over 30 watts. Even if the risk of overheating in the products themselves is resolved, heat generation in the cabling's core temperature may still be an issue. Although these concerns are not a cause for great alarm, system integrators should be aware of these issues when planning PoE+ cabling infrastructure installation and using nonstandard PoE products.

The following table provides a comparison between 802.3af and 802.3at:

	802.3af	802.3at
Voltage	44V	50V
Current	350mA	720mA
4-wires	12.95W	~30W
8-wires	N.A.	~60W

802.3af vs. 802.3at

Why You Need PoE Switches for Industrial Applications

As previously mentioned, PoE switches offer a more integrated solution compared to a traditional midspan system. In this section, we will discuss some of particular benefits PoE switches offer industrial applications.

Cost Saving

Industrial PoE switches only require a single CAT-5 cable for the network connection. This feature significantly reduces the power line installation cost for electrical wiring, conduits, and outlets throughout the industrial environment. It also reduces future maintenance costs, saving a great deal of money especially when wiring PoE technology for large systems.

In addition, industrial PoE switches also provide maximum flexibility for device installation. For industrial network applications such as mining, offshore oil platforms, and seaport monitoring, it is difficult to provide extra power for outdoor devices. With industrial PoE switches, system integrators can install PoE switches almost anywhere without the need for DC/AC power inputs.

Reliability

Using just one CAT-5 cable instead of separate cables for data and power improves overall network reliability and deployment flexibility. Although Power over Ethernet technology provides improved flexibility, it comes with added concerns such as power consumption and heat dissipation in PSE and PDs. This is because power sourcing equipment and powered devices in

industrial mission-critical applications must be operable at all times without any interruption. Industrial-grade PoE solutions are usually higher quality than commercial-grade products and offer longer MTBF time, wider operating temperature, fan-less design, and reliable PoE management.

Safety

The 48 VDC power design makes industrial PoE switches compliant with Underwriters Laboratories (UL) Safety Extra-Low Voltage (SELV) classification to provide users with a safe working environment. As an additional safety precaution in the Power over Ethernet network, users can set the power limitation for each port on the industrial PoE switch. Without this function, the PD will immediately request overload current from the PoE switch if its power supply circuit fails (e.g. the power circuit in a PoE camera shorts out due to excessive humidity), which will shut down the Ethernet switch and all related network communication. As a result, power limit configuration can protect PoE switches from providing too much power, even when requested by the powered device. An industrial PoE switch will not only safeguard against excessive power output, but also send alarm messages to the network administrator.

Security

Industrial outdoor security and IP surveillance for mines, military bases, or power substations are the most common PoE applications. When an anomaly in the PoE network occurs, the control center must receive a warning message immediately. Some industrial PoE switches include an auto-warning function that can send warning messages to the control center via e-mail or SNMP trap. Furthermore, the PoE switch includes input/output capabilities for triggering local alarms or message lights to help administrators locate the problem area easily. Using the SNMP, the administrator can power on/off the device remotely for added protection. The network administrator can also disable the power supply when the device is not in use or

is accessed by unauthorized personnel.

Advanced Management

For higher level security, industrial managed PoE switches provide network administrators with advanced monitoring and control capabilities. Users can remotely enable and disable the power output from the switch to powered devices. Therefore, some industrial PoE switches provide a PoE failure recovery function. This function will check the status of the device continuously, and when there is no response, the PoE switch will reset the device by powering it on and off until it returns to the default working status. The industrial PoE switch also provides an advanced scheduling function for the PoE network. Many PoE surveillance applications only need to be active during nights and weekends. Therefore, users can set up the PoE switch's schedule to enable or disable the PoE device at the appropriate time. By disabling PoE surveillance during the day, more network bandwidth can be used for data transmission. At night, the network bandwidth can be used exclusively for surveillance-related PoE data communication.

Summary

Security for industrial facilities has become more and more important in recent years. IP surveillance technology (e.g. video compression and streaming) and the performance of security devices (e.g. IP cameras, sensors, and card readers) have become more sophisticated and reliable, prompting rapid growth in the PoE device market. Industrial-grade PoE switches are key components in Power over Ethernet networks, providing total cost savings on power source installation and future maintenance, reliability and safety, real-time warnings for security issues, and a convenient PoE management function to monitor and control network devices.